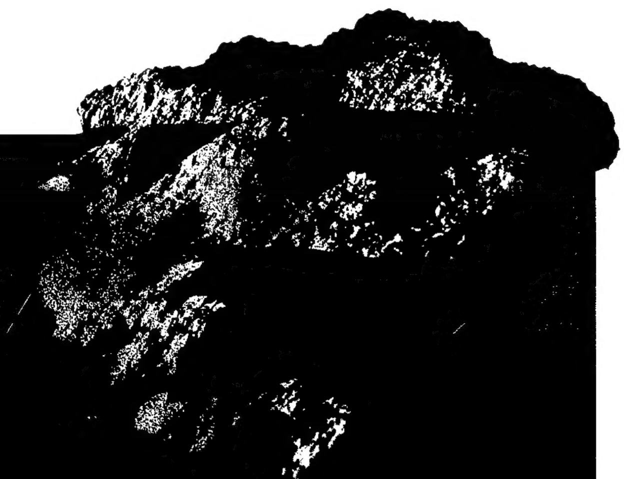
AIR FORCE RESEARCH LABORATORY [AFRL]
Manager of the Basic Research Investment for the Air Force Research Laboratory

Research

MAY
JUN
99



Space Tracking Technology Focuses on Deep Space

new, state-of-the-art space tracking technology will give the Air Force better situational awareness of the space environment by providing better detection and tracking of objects in deep space.

Dr. Grant Stokes

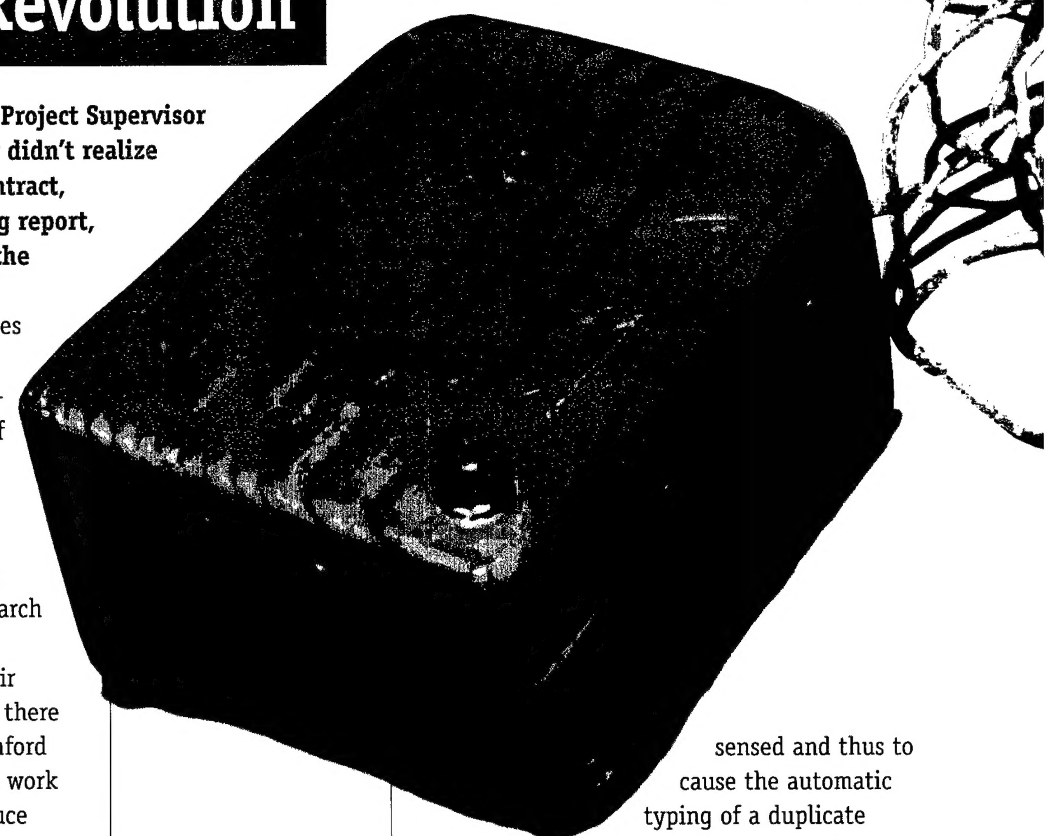
This new technology, developed by an AFOSR-supported research team lead by Dr. Grant Stokes at MIT-Lincoln Laboratory, improves the worldwide capability for detection of Near Earth Objects (NEOs) by 300 percent.

Basic research in detection and tracking of NEOs benefits the Air Force's mission in space by:

- Providing a test-bed to develop enhanced technology for the detection of smaller, fainter, and more slowly moving space objects, and
- Contributing to multi-agency initiatives intended to identify, catalog, and predict the orbits of space objects that may pose a threat to the Earth, or high-value space assets such as the International Space Station, among others.

continued on page 3...

AFOSR Provides Early Support for Principal Archi of Computer Revolution



Back in the early 1960's, AFOSR Project Supervisor Mrs. Rowena Swanson probably didn't realize the tremendous impact one contract, No. AF49(638-1024) and the resulting report, No. AFOSR 3233 would have on both the military and civilian community.

After all, the researcher's colleagues and prospective employers didn't offer much support for his vision of augmenting human intellect and the potential of computers to assist people in complex decision-making.

For some reason, AFOSR did see the potential and awarded a contract to Dr. Doug Englebart at the Stanford Research Institute.

"I got some money from a small Air Force Office for Scientific Research, and there was enough there along with SRI's (Stanford Research Institute) contribution I could work full time for a couple of years and produce what I called *Augmenting Human Intellect: A Conceptual Framework*," said Englebart in a May, 1994 interview.

That resulting work, published in 1962, serves as a sort of roadmap for developing computer technologies. Engelbart believed that the complexity of problems facing mankind was growing faster than the ability to solve them.

"We envisioned problem-solvers using computer-aided working stations to augment their efforts. They required the ability to interact with information displays using some sort of device to move (a cursor) around the screen," said Dr. Englebart in published interviews.

In his report, Engelbart gives some clues as to where computing would develop.

He suggested the development of an auxiliary device, a gadget "that is held like a pencil and, instead of a point, has a special sensing mechanism that you can pass over a line of the special printing from your writing machine (or one like it). The signals which this reading stylus sends through the flexible connecting wire to the writing machine are used to determine which characters are being sensed and thus to cause the automatic typing of a duplicate string of characters. An information-storage mechanism in the writing machine permits you to sweep the reading stylus over the characters much faster than the writer can type; the writer will catch up with you when you stop to think about what word or string of words should be duplicated next, or while you reposition the straightedge guide along which you run the stylus.

As the inventor of the mouse and scores of computer-related innovations, Dr. Engelbart has a thirty-year track record in predicting, designing and implementing the future direction of organizational computing.

Today, that gadget is known as a mouse.

"A bonus feature," as Engelbart describes it, would be a common working structure so that individuals, as part of a team, can work on the same project simultaneously. "The whole team can join forces at a moment's notice to 'pull together' on some stubborn little problem, or to make a group decision."

He called it inter-communication via computer, today it is called networking.

Englebart's report, with AFOSR support, is filled with concepts that have materialized and fueled the Information Age.

More information on Engelbart's work, *Augmenting Human Intellect: A Conceptual Framework*, as well as his current initiatives can be accessed at: **www.bootstrap.org**

tect

ABOVE: The first computer mouse was invented in 1963-64 as part of an experiment to find better ways to "point and click" on a display screen. Due to space restrictions, the first mouse (pictured above) had only one button and was carved out of wood. An improved mouse eventually contained three buttons — an "upgrade" that was limited due to space required for the three micro-switches.

continued from page 1...

The Lincoln Near-Earth Asteroid Research project, or LINEAR, uses a 1-meter aperture telescope located near Socorro, N.M. to detect and track potential NEO candidates. This telescope uses highly sensitive electronic devices called charge-coupled devices (CCDs) to photograph the sky, while computer algorithms process the images and quickly detect any changes from one observation to the next. Asteroid observations are forwarded to astronomers at the Minor Planet Center in Massachusetts, who then calculate the object's orbit and provide discovery acknowledgments.

The LINEAR system incorporates innovative technologies, including:

- Large format, highly sensitive, back illuminated CCDs,
- Fast frame transfer readouts that allows a new image to be collected while the previous image is being read out — thus yielding very high search efficiency,
- New camera systems for improved sensitivity, and
- Customized, high throughput data processing systems.

These technologies combine to allow LINEAR to search more than 12,000 square degrees per month, to a limiting magnitude of approximately 19.5 (250,000 times dimmer than the human eye can detect), compared with the typical 1,000 square degrees obtained by "competing systems."

This leads to a very productive searching system for NEOs, comets, and main belt asteroids. Since March 1998, LINEAR has been responsible for the discovery of more than 70 percent of the NEOs detected worldwide.

LINEAR's state-of-the-art technology is an integral part of the Air Force's initiative to modernize the Ground-based Electro-Optic Deep Space Surveillance, or GEODSS, system. The system, which consists of 1-meter telescopes and 1970's television technology, is part of the Space Surveillance Network run by the Air Force Space Command.

Additional information may be found at: **www.ll.mit.edu/LINEAR**

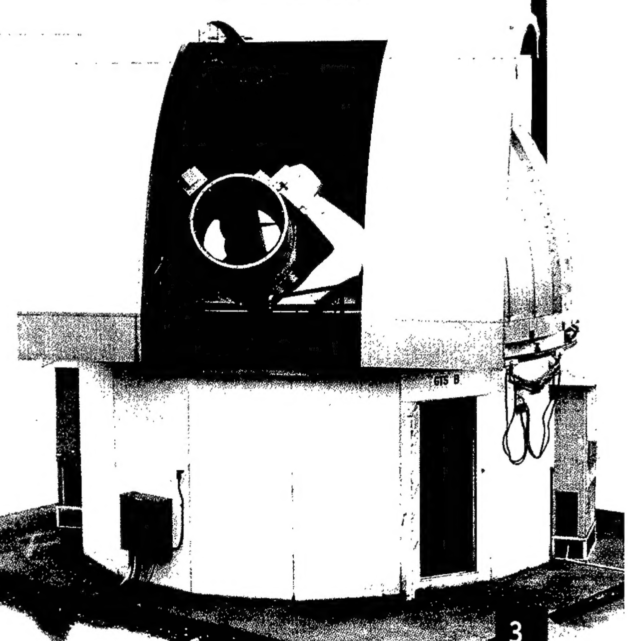
Maj. Paul Bellaire
Directorate of Mathematics and Space Sciences
(703) 696-8411, DSN 426-8411

Since March 1998, LINEAR has been responsible for the discovery of more than 70 percent of the NEOs detected worldwide.

Reprinted with permission of MIT Lincoln Laboratory, Lexington, Massachusetts

ABOVE: The red area shows the coverage of the earth during a given month, LINEAR achieves coverage of 12,000 degrees out of 16,000 degrees in the entire sky. The black area indicates areas that were not covered due to daylight, horizon blockage, weather, or other factors. The Ecliptic line shows the plane of the solar system where most asteroids exist. Undulation caused by 26 degree of earth rotation.

BELOW: The GTS-2 telescope is a 1-meter folded prime focus Cassegrain design identical to that of the Ground-based Electro-Optical Deep Space Surveillance (GEODSS) telescope used by the Air Force for space surveillance. It is located at the Experimental Test Site (ETS).



Research Investments in Information Security

Just as the Air Force saw value in supporting early computer research, AFOSR continues to support research that contributes to the Air Force's core competency of information superiority:

Information Warfare: Networks are becoming critical to day-to-day operations in both wartime and peacetime. Researchers are working on new methods to detect unforeseen network intrusions, automatically recover corrupted systems, and provide mechanisms for software to formally prove its own safety. Future systems will have to be able to dynamically adjust to a variety of hostile environments, detecting and responding to attacks that have never been seen before.

High Performance Knowledge Bases: The scope of military conflicts and the complexity of weapons systems continue to grow at an alarming rate. This research involves in-depth knowledge that is encoded into a form that allows the computer to perform abstract reasoning and provide expert support for human decision-makers. While current knowledge bases contain around 10,000 axioms, future knowledge bases will contain 10 million axioms. The difference in capabilities is that, while current knowledge bases can, for example, *trouble-shoot* car problems, future knowledge bases will be able to *design* a car. Current knowledge bases can answer complex geo-political questions such as: *"What are Saudi options to respond to Iran's closing of the Straits of Hormuz?"*

Intelligent Agents: This research involves creating software entities that act on the behalf of a human. Agents are typically proactive, autonomous, highly personalizable and sometimes mobile, with the capability to independently move across networks to different machines. Agents seek out information and solve problems on their own, with little involvement from the human. Software agents have the potential to completely revolutionize the way we use computers, making the process much more like human to human interaction.

Component-Based Software: Software is often still the most difficult part in any new weapon system development. This research is developing new theoretical foundations to allow "tinker toy" type software development, where proven components can be easily assembled to produce complete software systems in much less time than in the past. These components can easily be re-used across different systems, and customized for the task at hand without requiring any knowledge of the underlying structure of the component.

Capt. Alex Kilpatrick
AFOSR/NM
(703) 696-6565, DSN 426-6565

Research Highlights

Air Force Office of Scientific Research
Communications and Technical Information
4040 Fairfax Dr. Suite 500
Arlington, VA 22203-1613

Director: Dr. Joseph F. Janni

Web site: www.afosr.af.mil

DSN 426-7311 or 426-3722
Comm: (703) 696-7305 or (703) 696-7307
Fax: (703) 696-7320
e-mail: afosrinfo@afosr.af.mil

Editor: Jean Schaefer

Research Highlights is published every two months by the Air Force Office of Scientific Research. This newsletter provides brief descriptions of AFOSR basic research activities including topics such as research accomplishments, examples of technology transitions and technology transfer, notable peer recognition awards and honors, and other research program achievements. The purpose is to provide Air Force, DoD, government, industry and university communities with brief accounts to illustrate AFOSR support of the Air Force mission. *Research Highlights* is available on-line at:

http://www.afosr.af.mil

To access our web-site, click on the Research Products and Publications icon, then on *Research Highlights*.

To find out more about AFOSR *Research Highlights* past issues and featured articles, visit us at:

www.afosr.af.mil

Have an idea for a story? Contact Jean Schaefer at: (703) 696-7305 or by e-mail at: afosrinfo@afosr.af.mil

Air Force Research Laboratory | AFRL

Science and Technology for Tomorrow's Aerospace Force

Air Force Office of Scientific Research
Communications and Technical Information
4040 Fairfax Drive, Suite 500
Arlington, VA 22203-1613